

Research Report 1444

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Remedial Skills Training: An Evaluation of Computer and Videodisc-Based Courseware

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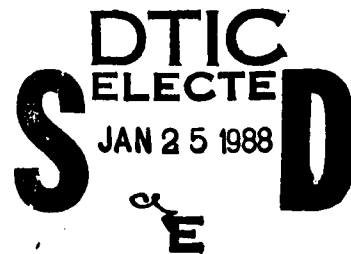


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FOREWORD

The principal mission of the Training Research Laboratory of the Army Research Institute is to refine the Army's training methods and practices. As part of this refinement, the mission of ARI-Fort Knox and the Training Technology Field Activity (TTFA) is to develop, evaluate, and implement new technologies and methods into Army training. The TTFA's recent efforts have focused on the potential of computer and videodisc-based instruction (CVBI) for Armor training. This research effort evaluated the training efficiency and effectiveness of CVBI courseware developed by the TTFA to train the remedial skills prerequisite to the Basic Noncommissioned Officer Course (BNCOC) for M1 tank commanders.

This effort is part of the ARI-Fort Knox Field Unit's research program to apply new training technology to Armor skills training. A Memorandum of Agreement covering the application of training technology to Armor skills training, "Establishment of Field Training Technology Activity, Fort Knox, Kentucky," was signed by the U.S. Army Training and Doctrine Command (TRADOC), the U.S. Army Armor Center (USAARMC), and the U.S. Army Research Institute (ARI) on 4 November 1983. Results from this evaluation of CVBI remedial courseware were provided to the Chief of the Training Technology Field Office at Fort Knox and briefed to the Technical Director of the U.S. Army Armor School and TRADOC's Deputy Chief of Staff for Training. Successful implementation of this courseware into BNCOC would support the transfer of this courseware to other Army training systems.



EDGAR M. JOHNSON
Technical Director

REMEDIAL SKILLS TRAINING: AN EVALUATION OF COMPUTER AND
VIDEODISC-BASED COURSEWARE

EXECUTIVE SUMMARY

Requirement:

To evaluate the effectiveness of computer and videodisc-based courseware for training remedial skills to M1 tank commanders.

Procedure:

As part of the Training Technology Field Activity (TTFA) mission to provide innovative training technologies for Army training, computer and videodisc-based instruction (CVBI) was developed for training a set of remedial tasks that are prerequisite skills for admission into the 19K Basic Noncommissioned Officer Course (BNOCC) for M1 tank commanders. The training effectiveness of this CVBI was evaluated with control ($n = 44$) and experimental ($n = 39$) groups of military personnel similar to soldiers in 19K BNCOC. All training and tests were on-line products provided by a CVBI delivery system. A pretest versus posttest design with several control conditions were used to determine the CVBI's training effectiveness.

Findings:

Results for the four remedial tasks included in this evaluation--Use Visual Signals, Establish Tank Firing Positions, Determine Grid Coordinates, and Identify Armored Vehicles--showed significant improvements in posttest performance. In addition, participants' subjective evaluations of this CVBI clearly indicated they prefer CVBI over conventional training methods. While training efficiency could not be directly determined, the diversity of participants' need for remedial training strongly supports the adaptive nature of training technologies such as CVBI in the Army training system.

Utilization of Findings:

The findings of this evaluation were provided to the Technical Director of the Armor School who recommended validation of this courseware in the 19K BNCOC Program of Instruction. To facilitate the transfer of this CVBI, the courseware should be revised to meet the functional specifications of the Electronic Information Delivery System (EIDS). As the designated Army standard for CVBI, EIDS has further established the Army's commitment to incorporating these TTFA training technologies into the Army training system.

REMEDIAL SKILLS TRAINING: AN EVALUATION OF COMPUTER AND VIDEODISC-BASED COURSEWARE

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REMEDIAL SKILLS TRAINING: AN EVALUATION OF COMPUTER AND VIDEODISC-BASED COURSEWARE

INTRODUCTION

While the Army training system has incorporated numerous new technologies in recent years, it is still heavily dependent upon approaches from an earlier era, such as use of paper materials and classroom lecturing techniques. In an operational training environment it is difficult to test and apply promising technologies and innovations, especially given the rapid rate at which technologies are being developed today.

To overcome this difficulty the U.S. Army Training and Doctrine Command (TRADOC), the U.S. Army Armor Center (USAARMC), and the U.S. Army Research Institute (ARI) have established a Training Technology Field Activity (TTFA) at Fort Knox, Kentucky. The mission of the TTFA is to systematically identify, evaluate, and introduce new training methods, techniques, technologies, and models to Army training. A more complete discussion of TTFA's background, approach and scope of effort is provided by Kristiansen (1986).

The current efforts of the Fort Knox TTFA have focused on the Basic Non-commissioned Officer Course for M1 tank commanders, 19K BNCOC. TTFA's initial projects have attempted to develop and implement computer and videodisc-based (CVBI) training technologies. For these initial projects two blocks of instruction, clusters of tasks, were selected from the BNCOC Program of Instruction (POI) for conversion to CVBI. The first block, land navigation, included training and testing for five common military tasks regarded as fundamental to daytime land navigation. CVBI courseware for these tasks was developed (Elder, Harris, Sticha, Stein, Knerr, & Tkacz, 1985), and its training effectiveness and efficiency was evaluated at Fort Knox (Lickteig & Burnside, 1986). For the second block of instruction, remedial training, CVBI courseware was developed for a set of prerequisite skills that are required for admission into the 19K BNCOC course. This paper reports on the evaluation of this remedial courseware's training effectiveness.

BACKGROUND

As recommended by the Defense Science Board's 1982 Summer Study on Training and Training Technology, the TTFA initiated a program of research and development to explore the design, application and effectiveness of innovative training technologies. Once 19K BNCOC was selected as the initial focus of these training technologies, the TTFA ensured that this course's redesign and development was guided by the Systems Approach to Training (SAT) as detailed in TRADOC Reg 350-7 (1982). Consistent with the Instructional System Development (ISD) model, this course development was based on a thorough analysis of the training requirements for 19K BNCOC (Drucker, Hannaman, Melching, & O'Brien, 1985). A primary goal of this analysis was to identify those tank commander tasks critical for mission accomplishment and individual survival on the battlefield. This analysis also identified a set of tasks that were prerequisite requirements, skill level (SL) 1 and 2, to the SL 3 tasks equivalent to the 19K30 course classification.

In a subsequent phase of this SAT effort training systems and technologies were reviewed and analyzed for their applicability to the 19K BNCOC POI (Drucker et al., 1985). A total of 27 different training systems were identified for consideration by BNCOC training developers, and the potential implications of implementing each of these training systems into the BNCOC course were analyzed with respect to the course's training developers, instructors and students. As for training technologies, the SAT analysis noted the Army's increasing use of automated training technologies and in particular computer-based instruction (CBI) and computer-managed instruction (CMI). One of the most innovative technologies identified in this analysis was interactive videodisc which combines the high fidelity imagery of instructional television with the powerful instructional features of CBI.

The SAT analysis in conjunction with an SAT design for the BNCOC course (Morrison, Drucker, & O'Brien, 1985) ensured that the TTFA's efforts in 19K BNCOC were guided by, and in accordance with, the initial phases of the ISD model for course development and revision.

With this background the TTFA then moved to the next ISD phase, courseware development. The TTFA effort for 19K BNCOC entailed courseware development efforts for most of the subject or content areas included in the classroom portion of the POI such as land navigation, communications, fire commands, call for and adjust indirect fire as well as nuclear, biological and chemical (NBC) defense. This report, however, is limited to the evaluation of one additional block of BNCOC courseware, remedial training, and will begin with a brief discussion of this particular courseware's design and development.

REMEDIAL COURSEWARE DESIGN AND DEVELOPMENT

Courseware Content

As the TTFA's focus shifted from the overall analysis and design of the BNCOC course to the remedial training requirements for tank commanders, candidate tasks for prerequisite training were thoroughly reviewed (Knerr, Elder, Campbell, Stein, Sticha, & Morrison, 1986). This analysis included the previously noted prerequisite tasks identified during the overall SAT analysis (Drucker et al., 1985), the tasks currently included in the BNCOC diagnostic tests, and prerequisite tasks listed in the Soldier's Manuals FM 17-19K 1/2/3. In addition, this preliminary analysis of remedial tasks included interviews with instructors and course managers, review of the student performance records on diagnostic tests, and guidance by a steering committee of subject matter experts.

The original pool of 70 remedial tasks identified as potential candidates for the remedial courseware was reduced to 21 by eliminating tasks with previously high pass rates, tasks not directly related to SL 3 tasks included in the POI, and tasks recommended for the requisite POI by the SAT design effort (Morrison et al., 1985). From these 21 tasks, the following set of 5 prerequisite tasks for remedial courseware development were selected on the basis of their testability and suitability for CBI:

- o Determine grid coordinates of a point on a military map using the military grid reference system (Task 071-329-1002).
- o Communicate using visual signalling techniques (Task 071-326-0608).
- o Recognize and identify friendly and threat armored vehicles (Task 878-920-1001).
- o Establish tank firing positions (Task 171-123-1008).
- o Operate a radio set (Task 113-587-2043).

These five SL 1 tasks were then subjected to standard and cognitive task analyses to: identify common errors, determine the relative difficulty of learning the tasks, and infer the cognitive structures underlying their skill acquisition and performance. Training strategies and learning principles for each of these tasks were then derived by application of the Training Effectiveness and Cost Prediction (TECEP) method. For a more complete discussion of these remedial courseware analysis and design phases the reader is referred to Knerr et al. (1986).

Courseware Delivery: Training Technologies

As part of TTFA's mission to implement innovative training technologies into Army training, the land navigation courseware was designed and developed as computer-based instruction (CBI). The positive instructional characteristics associated with CBI such as reliability, standardization, cost effectiveness, interactivity and immediate feedback have been well articulated (e.g., Ellis, 1986; Heinrich, 1985; Orlansky & String, 1981). A more innovative technology included in the courseware design was the use of videodisc imagery for depicting live-action modeling of task performance and dynamic real-world terrain scenes. Interactive video provides a number of unique features such as fidelity of visual and audio training materials, random and rapid access, multiple speeds and directions, and the potential for interactive and individualized instruction. A more complete discussion of the merits of interactive video, beyond the current scope, is available (Hannafin, 1985; Reigeluth & Garfield, 1984).

With respect to the current TTFA implementation, instructional experts suggest that interactive video may be particularly effective in applied training settings and in an effort to solve troublesome training issues not resolved by conventional training methods (Woolley, 1982). In summary, an interactive, multimedia training package was developed by interfacing the computer-based instructional materials, text and graphics, with supporting videodisc-based materials, both video and audio.

The Fort Knox TTFA effort utilized the MicroTICCIT System II developed by the Hazeltine Corporation. Time-Shared Interactive Computer-Controlled Information Television (TICCIT) is an integrated hardware, software and courseware development system designed for the efficient production, delivery and management of computer-based instruction. This system is not only tailored to meet the training developer's needs for courseware authoring and delivery,

but also for computer managed instruction (CMI) in which student records and progress are automatically monitored and maintained. System II was designed for mid-scale (i.e. 40 workstations) CBI implementations, consistent with the current and projected 19K BNCOC roster size. MicroTICCIT was also selected because of its ability to integrate peripheral instructional technologies such as the interactive videodisc used for this remedial courseware, and speech synthesis and recognition systems used in other TTFA courseware developments for BNCOC.

Courseware Structure

The remedial courseware structure was based on MicroTICCIT's ADAPT, Level 3, authoring language and courseware structure. ADAPT provides four levels of instruction: course, unit, lesson and segment (CULS); and an underlying map hierarchy to process the sequencing of instructional materials. Courseware for each of the five remedial tasks was designed as a separate lesson within the Remedial Unit, and under the 19K BNCOC Course. All training and tests for each of the five remedial tasks were on-line CBI products. Each of these five lessons, corresponding to the five remedial tasks, contained a number of segments which with minor exceptions were as follows:

- o Objective
- o Instruction
 - Review
 - Help
- o Practice
 - Feedback
 - Help
- o Test

These segments were presented to the students through a hierarchical series of menus. All student requests from these menus and all student inputs and responses were entered by means of a lightpen. The segments are briefly described in the following paragraphs.

The Objective presented the overall training goal, terminal objective, of the lesson and included the conditions, actions and standards associated with the task. The Instruction segment provided the actual training for the task and integrated text, video, audio and graphic instructional materials. In support of this instructional segment, the Review component provided students an opportunity to quickly access informative summaries of the complete instructional package, and the Help component provided additional explanatory information specific to key issues addressed by the instructional segment. The Practice segment provided students the opportunity to pretest their mastery of the instructional requirements with sample items similar to those included in the final test. Students responses were evaluated by the Feedback component which provided them immediate knowledge of their results for individual practice items, and assessed their readiness to advance to the Test segment.

The test segment consisted of performance-oriented knowledge tests which have also been described as synthetic tests (Osborn, 1970; Osborn and Ford, 1978). The intent of performance-oriented knowledge tests is to provide a reliable and valid indicator of student mastery in the absence of hands-on performance evaluation measures. Key features of performance-oriented knowledge test are that task stimulus conditions are simulated, and facsimilies of actual task responses are required for test performance. Performance-oriented stimulus and response conditions for this courseware are described in the subsequent Courseware Instruction and Evaluation Measures sections. A comparison of these remedial performance-oriented knowledge tests with conventional hands-on measures was conducted and is provided by Knerr et al. (1986).

Courseware Instruction

The courseware was designed to maximize the training potential of the innovative technologies included in this TTFA effort. In particular, this CVBI courseware attempted to provide a multimedia training package responsive to remedial and individual training requirements. The following section provides a brief description of this CVBI training for each of the five remedial tasks and the manner in which these training technologies were integrated into the remedial courseware package for 19K BNCOC.

Determine Grid Coordinates. After a review of the lesson's objective, the instruction for this task proceeded to a videodisc-based live-action model of a soldier in a typical field setting demonstrating and explaining how to determine grid coordinates. Text and graphic messages were used to reinforce these procedures and emphasize the following two task actions: (1) determine the 6-digit coordinates for points marked on the map, and (2) mark the point on the map corresponding to the 6-digit coordinates designated. Designated coordinates and locations appeared on the student's workstation monitor which also displayed a standard 1:50,000 military map, marginal map information, and a graphic overlay of a numerical key pad for inputting each student's coordinate responses.

Use Visual Signals. This instructional segment began with a live action model of a soldier explaining why visual signals were important and demonstrating various examples of the 44 arm-and-hand, flag and light signals included in the lesson. Examples were reinforced with helpful hints for remembering each signal. Signals normally given by a tank commander were filmed showing the commander signalling from the commander's hatch on the tank. Signals normally received by the tank commander were filmed as viewed by the commander. During the practice items students were required to identify either signals received, or to select, from a split-screen presentation of four visual messages, signals to be given.

Identify Armored Vehicles. The instruction began with a narrator asking student's to imagine they were in a tactical situation and in a turret-down position. The narration emphasized the need for immediate and accurate identification given the combat scenario. Students were then presented with full color, scale-model images of 30 friendly and threat armored vehicles as viewed from five different perspectives. Key recognition features and the armament of each vehicle were highlighted by graphic arrows, and the correct

nomenclature (i.e., weapon system model) was provided. Practice items first required students to indicate whether the vehicle was a friendly or threat weapon system and then to select, from a multiple-choice list, the correct nomenclature. Students were allowed 10 seconds for each of these responses.

Establish Tank Firing Positions. This lesson began with a discussion and graphic presentation of tanks in various turret-down, hull-down and hide positions in a field setting. Graphic aids were used to illustrate the observation and fields of fire available from each position, and the relative coverage and concealment provided by each position. During the practice items for this lesson students were required to "move" the tank images across the monitor and into each of these positions as designated. This instruction also included a discussion and illustrations of the primary, alternate and supplementary tank firing positions used in the defensive battle position. Students were required to designate each of these positions for various combat situations.

Operate a Radio Set. The instruction for this lesson was based on a graphic simulation of an AN/VRC-64 radio on which all switches and dials could be set or adjusted to any realistic position via the lightpen. The instruction, using both video and audio, differentiated the various dials and settings required for preparing, operating and shutting down the radio system. Setting sequences with fixed or random orders were emphasized. In addition, students were provided a hard-copy of the Communications Electronic Operations Instructions (CEOI) for determining the operating frequency, call signs and authentication procedures. For practice items students were required to set the dials and switches required for preparing, operating and shutting down the system and to input information as required from the CEOI.

It must be noted, however, that during the pilot phase of this evaluation it was discovered that one of the key switches on the simulated radio could not be properly set. Neither in-house nor contractor personnel were able to identify the cause of this problem or correct it. Since this problem would prevent students from successfully completing the practice and test items, the courseware for this task was not included in this evaluation and will not be considered in the following sections. Action is underway to correct this problem so that the courseware can be tested in subsequent evaluation efforts.

RESEARCH OBJECTIVES

The primary research issue was to determine the training effectiveness of the remedial CVBI courseware. It was hypothesized that the courseware would significantly increase soldiers' posttest scores, above their pretest scores, for each of the four remedial tasks addressed by this courseware. Two control conditions were included to counter the alternative hypotheses that posttest increases may have been caused by soldiers' increased familiarity with the pretest items and/or the courseware delivery system, due to each participants approximately three hours of testing and training. Additional research issues were to evaluate the courseware's training efficiency, in terms of time required to complete the training, and the ease-of-use soldiers experienced with the courseware.

METHOD

Participants

Participants for this research were E3-E5 personnel stationed at Fort Knox with either an Armor (MOS 19K) or a Calvary (MOS 19D) military background. They were selected as a sample representative of the NCOs that might receive this courseware in the formal program of instruction (POI) for M1 tank commanders, 19K BNCOC. Thirty-nine soldiers, the remedial group, participated in the formal evaluation. An additional 44 soldiers, the land navigation group, served as a control group for this evaluation. Participants from both of these groups averaged just over three years of military service, with a range of one to eight years. They also averaged 23 years of age, with a range of 19 to 30 years of age. Almost all (93%) participants had completed high school, and nearly one out of four had completed some college courses. Most of them reported little or no computer experience. Based on an informal comparison with biographic data of 19K BNCOC personnel, both samples appeared representative of 19K BNCOC attendees. Due to the formative aspects of this evaluation and the limited number of student workstations available, it was decided not to disrupt the BNCOC course cycle by using students currently enrolled in 19K BNCOC.

Apparatus

The CBI for this evaluation was supported by a MicroTICCIT (System II) host computer networked to the student workstations. Each workstation included the following hardware:

- o IBM PC 256K bytes RAM
- o Sony videodisc player 1000 or 1000A
- o 12" Sony color monitor
- o Lightpen and stereophonic headset

All courseware was developed using MicroTICCIT's ADAPT, level 3, authoring language. In addition, students at each station were provided a set of paper copy topographic maps and a stereophonic headset, to insure a direct link with the auditory portions of the instruction and to reduce the probability of students being distracted by any ambient noise.

Design of the Evaluation

The independent variable in this evaluation was the remedial training as presented by the CVBI courseware. The dependent measure was the overall gain score (posttest minus pretest) for each of the four remedial tasks. T-tests were performed for both paired and independent samples as appropriate (Jaccard, Becker, & Wood, 1984).

There were two control conditions included to address the alternative explanations that significant increases on posttest measures were due to soldiers' increased familiarity, gained during the course of their training

session, with the test items and the computer delivery system (King & Roblyer, 1984). For each control condition participants completed pretests and posttests that were unrelated to the training they received. For the first control, participants in the remedial group completed pretests and posttests on two land navigation tasks--Identify Terrain Features and Determine Elevation--unrelated to the remedial courseware. In the second control condition, soldiers from the land navigation group completed pretests and posttests on two remedial tasks--Communicate Using Visual Signals and Establish Tank Firing Positions--before and after their training and tests on land navigation.

The training and testing sequence for both the remedial and land navigation groups is provided in Table 1. Control conditions, in which pretests and posttests were unrelated to the training received, are also indicated. The training and tests for these two blocks of courseware, remedial and land navigation, were independent with no overlapping content. But the tests and training for each block of courseware were presented by the same computer delivery system.

Table 1

Training and Testing Sequence for Remedial and Land Navigation Groups

Group	Sequence				
	Pretest ^a	Pretest	Training	Posttest	Posttest ^a
Remedial	Land Nav	Remedial	Remedial	Remedial	Land Nav
Land Nav	Remedial	Land Nav	Land Nav	Land Nav	Remedial

^aIndicates control conditions in which pretests and posttests were unrelated to training received.

Instruments

As noted above, the primary instrumentation involved in this evaluation was provided by the MicroTICCIT host computer and the supporting workstations. All training courseware and all pretest and posttest measures for both groups were on-line products supplied directly by the MicroTICCIT system.

In addition, a number of off-line instruments were also administered including a biographical questionnaire, a courseware evaluation questionnaire, and a student record sheet. The biographical questionnaire included a number of items concerning the participant's military and educational background and prior computer experience. The courseware evaluation questionnaire contained two 5-point Likert scale items that asked the participants to rate the overall training effectiveness of the courseware, and several open-ended items

for obtaining any recommendations they might have for improving the courseware. Finally, the student record sheet, which was maintained by the classroom proctors, provided a data sheet for recording summary scores, time requirements for training and testing, and a log for recording system malfunctions, student problems and proctor interventions. Complete copies of each of these off-line instruments are provided in Appendix A.

Procedure

Soldiers were trained and tested individually as they worked at their assigned student workstation. Prior to the training session each participant received a brief on-line introduction and orientation to the MicroTICCIT system. This introduction explained the organizational structure of the courseware and its supporting menu and prompt messages. In addition, this introduction familiarized students with the use of the lightpen and the availability of an Advisor function to assist them through the courseware. All student inputs, requests and answers were entered by using a lightpen. After each participant completed this orientation, pretests were administered for each task.

Upon completion of all pretests, participants from the remedial group began their training on the remedial courseware, and participants from the land navigation control group, on the land navigation courseware. Any participant passing the pretest for a given task was excluded from the training and posttest for that task. This exclusion of participants not requiring remediation is consistent with 19K BNCOC's procedures for diagnostic testing, and prevents an underestimation of the courseware's training effectiveness due to ceiling effects.

While all participants were directed to complete the initial objective and instruction components for each of the tasks trained, their training curriculum thereafter was determined by their self-selections and computer-based prompts. Instructional prompts based on each soldier's response and error patterns were provided by the on-line Advisor. For example, a student making an error on practice problems might automatically be referred by the Advisor to a related help component. Or after successfully answering a preset number of practice problems, the student would then be further advised that he was probably ready to take the appropriate test.

The posttest for each task was administered immediately after the training for that task was completed. Participants then proceeded through training on the remaining tasks, maintaining the same train-test sequence. All participants were allowed to take short breaks at their discretion, but they were instructed not to discuss the training and test material until after they had completed all courseware and posttest measures.

After finishing all training and related posttests, participants were administered posttests on the control tasks for which they had received no training. Finally, all participants were asked to complete a very brief courseware evaluation questionnaire, and the classroom proctors recorded any extended comments or recommendations they made about improving the courseware and training procedures.

Each soldier's session lasted approximately three hours depending upon the participant's pace in completing the training and testing requirements. Throughout the entire session, classroom proctors were present to assist students with any problems, input proctor functions for accessing the tests which were not directly accessible to students, and record both test scores and participants' comments.

Evaluation Measures

All criterion measures, the pretest and posttest scores, were generated from on-line courseware materials. Tests for each of the four remedial and two land navigation tasks consisted primarily of multiple choice items. Students indicated their answers by selecting with the lightpen their choice from among those response alternatives appearing on their workstation monitor. Number of test items and choices per item varied as a function of courseware content and design. A brief description of each test is provided below.

Determine Grid Coordinates. For this test there were two types of evaluation items. In the first, students determined the six-digit coordinates and two-letter 100,000-square-meter identifiers for points indicated on maps displayed on the workstation monitor. Answers were entered using the lightpen and a numerical keypad displayed in one corner of the screen. For the second set of items, students used the lightpen to move a cursor across their monitor-based maps to the location of the coordinates designated. The test consisted of five items from each type.

Use Visual Signals. For this test various hand-and-arm, flag, and flashlight signals were demonstrated by soldiers in field settings via the student monitor. Students were then required to either select, from a multiple-choice list, the name of a signal demonstrated, or indicate which of the four signals shown was the one named. The test consisted of 16 of these items.

Identify Armored Vehicles. For this test students were shown pictures of 30 friendly and threat armored vehicles as viewed from various perspectives. Students were required to identify each vehicle as friendly or threat within 10 seconds, and then to select the correct nomenclature within an additional 10 seconds.

Establish Tank Firing Positions. For this test students were presented pictures of tanks in hull-down, turret-down, and hide positions, as well as primary, alternate, and supplementary firing positions. The test consisted of 12 questions for which students were required to correctly identify positions depicted or "move" their tanks into positions designated.

Identify Terrain Features. The test for this control task required students to identify eight major terrain features indicated on various maps displayed on the screen. Students used the lightpen to either pick out an example of a designated feature on a map or identify the name of the feature highlighted by computer graphics. The test consisted of 12 items, six of each type.

Determine Elevation. The test for this control task required students to determine the elevation of various terrain points as designated on their monitor-based maps. Answers were entered using the lightpen and the numerical keypad displayed on the screen. The test consisted of six such items.

Pretest and posttest scores were obtained by assigning one point to each test item correctly answered for all tasks except Identify Friendly and Threat Armored Vehicles. For this vehicle identification task scoring was as follows: each correct answer scored plus two points, each wrong answer minus two points, and each "don't know" answered minus one point (to discourage guessing). To ensure equivalent measures, identical items were used for both the pretest and posttests. For a more complete description of the test items the reader is referred to Knerr et al. (1985).

RESULTS AND DISCUSSION

Tasks Not Trained

As previously discussed, the research design for this evaluation was a pretest-posttest design in which the effects of training were based on improvements or gains in students' posttest scores over and above their pretest scores. Higher posttest scores, however, may have been due to students increased familiarity with the computer-based training delivery system and/or the test items and formats rather than the training itself. To partially control for these potentially confounding effects, each participant from the remedial group completed on-line tests for two nontrained tasks before and after their work with the remedial courseware.

A summary of the remedial group's control data on tasks for which they were not trained--Identify Terrain Features and Determine Elevation--is presented in the upper portion of Table 2. The average gain scores for these two tasks, .31 and .31, were relatively small. Paired comparison t-tests revealed a modest but nonsignificant improvement on these control tasks, $t(38) = .93$, $p > .36$ for the Identify Features task and $t(38) = 1.48$, $p > .14$ for the Determine Elevation task.

More direct evidence for ruling out the effects of computer-experience and test familiarity on the remedial tests per se, rather than the unrelated land navigation tests, was provided by data from the land navigation group which is also included in the upper portion of Table 2. As stated, the land navigation group was tested but not trained on two of the remedial tasks--Communicate Using Visual Signals and Establish Tank Firing Positions. Their average gain scores for these tasks, .43 for Signals and .30 for Positions again showed no significant improvement in the absence of training. Paired comparison t-test values were $t(43) = 1.61$, $p > .11$ for the Signals task and $t(42) = .96$, $p > .33$ for the Positions task.

In conclusion, the modest and nonsignificant gain scores for the four tasks not trained provide supporting evidence that any significant improvements obtained on tasks trained were probably not caused by familiarity with the test items and/or the computer-based delivery system. More direct evidence is provided in the following section where these modest improvements

due to familiarity are directly compared with improvements caused by training.

Table 2

Summary of Results for Tasks Trained and Tasks Not Trained

Tasks	Number ^b of Soldiers	Number of Items	Pretest Average	Posttest Average	Gain Average
Not Trained					
Signals ^a	44	16	11.02	11.46	.43
Positions ^a	43	12	6.41	6.63	.30
Features	39	12	8.59	8.90	.31
Elevation	39	6	2.20	2.51	.31
Trained					
Signals	34	16	11.03	14.59	3.56
Positions	27	12	7.29	11.48	4.19
Coordinates	24	10	4.38	7.96	3.58
Vehicles	25	24	8.99	15.9	6.90

Note. Task names refer in order to the following tasks: Communicate Using Visual Signals, Establish Tank Firing Positions, Identify Terrain Features, Determine Elevation, Determine Grid Coordinates and Identify Friendly and Threat Armored Vehicles.

^aIndicates control tasks from land navigation group, all other data from remedial group.

^bNumbers of soldiers completing both pretests and posttest. Original pretest samples were $\underline{n} = 44$ for land navigation group and $\underline{n} = 39$ for remedial group.

Tasks Trained

Training Effectiveness. Summary data for the four remedial tasks trained and evaluated--Communicate Using Visual Signals, Establish Tank Firing Positions, Determine Grid Coordinates and Identify Friendly and Threat Armored Vehicles--are presented in the lower portion of Table 2. As noted in the Procedure section, participants who passed the pretest for any task were excluded from the training and posttest for that task. The number of soldiers receiving the remedial training, therefore, varied by task as indicated in the first column.

For the remedial tasks trained, improvement in participants' posttest performance is indicated by the average gain scores presented in the last column of Table 2. Gain scores for tasks trained ranged from 3.56 for the Signals task to 6.9 for the Vehicles task, relatively large gains compared to those obtained for tasks not trained. Paired comparison t-tests of pretest

versus posttest performance for each of the four remedial tasks revealed highly significant increases in soldiers posttest scores, all p values less than .001.

A more direct test of the courseware's training effectiveness is available for the two remedial tasks--Communicate Using Visual Signals and Establish Tank Firing Positions--on which the land navigation group was tested, but not trained. Between groups, remedial versus land navigation, t -test comparisons of these gain scores were highly significant, $t(76) = 7.72$, $p < .001$ for the Signals task, and $t(68) = 6.86$, $p < .001$ for the Positions task. This finding of significantly greater gains for the remedial group on tasks trained compared with the gains of the land navigation group on these same tasks provides the most direct evidence of the courseware's training effectiveness.

A more practical indicator of this courseware's training effectiveness may be a more traditional measure of student performance, percentage of test items correctly answered. Table 3 provides a summary of the percentage of test items correctly answered for both tasks trained and tasks not trained. These data represent test scores for soldiers who failed the pretests and thus took the training and posttests. The gain scores for tasks trained, ranging from 22% to 36% improvement, demonstrate a significant training effect. Gain scores for tasks not trained, ranging from 2% to 5% improvement, were not significant and again dispel the rival hypotheses of increased familiarity.

Table 3

Average Percentage of Test Items Correctly Answered

Tasks	Pretest	Posttest	Gain
Not Trained			
Signals ^a	69	72	3
Positions ^a	53	55	2
Features	72	74	2
Elevation	37	42	5
Trained			
Signals	69	91	22
Positions	61	96	35
Coordinates	44	80	36
Vehicles	36	66	30

^aIndicates data from land navigation group, all other data from remedial group.

In the case of a normative course standard (i.e., Pass = 70%), the remedial courseware raised "class" averages for the Table 3 participants from "No Go" to "Go" for all tasks trained except Identify Friendly and Threat Armored

Vehicles. Actual course standards for these remedial tasks have yet to be established since only one of these tasks, Determine Grid Coordinates, is included in 19K BNCOC's current POI. Course standards are an important consideration that is beyond the scope of this evaluation. But it should be noted that standards for these remedial tasks for personnel entering the Army may not be adequate for the more experienced soldiers typical of 19K BNCOC; and conventional test measures currently used for entry personnel are not always directly relatable to computer-based testing.

With respect to the Identify Vehicles task, the identification of 30 friendly and threat vehicles is a demanding task as indicated by the participants' relatively low pretest performance. In addition, answers were scored correct only if provided within 10 seconds. Nevertheless, this is a critical M1 tank commander task and the data indicate that some participants may need to be retrained and retested on Vehicle ID. Another alternative is that the on-line Advisor function for recommending that a participant is probably ready for Vehicle ID testing, based on percentage of practice items answered correctly, be made more stringent.

Other data related to training effectiveness were obtained from the participants' subjective evaluation of the courseware as recorded on the Post-test Questionnaire. On the average, participants rated the courseware's training effectiveness as 4.2 on a 5-point scale (verbally anchored with "Good Training" for a 4.0 rating and "Very Good Training" for a 5.0 rating). In general, 90% of the participants rated this CVBI training as either "Good" or "Very Good," and only 1 of the 39 participants rated the courseware as below average training. Another evaluation item asked participants to directly compare the effectiveness of the CBI courseware with conventional training on the same tasks. Ninety two percent of the participants rated the courseware as "Better" or "A Lot Better" than conventional training, and only one participant rated conventional training superior to the computer-based instruction.

Participants also responded to a number of open-ended items on the Post-test Questionnaire that asked about their overall reaction to the CVBI courseware, and more specifically which instructional features were most and least liked. Over half of the participants commented favorably on the self-paced nature of the computer-based training and the option to review instructional segments as often as required. Selected comments concerning the option to review instructional segments were "retraining on the spot," "able to go back as many times as I need," and "great to train where I got a No Go." Concerning the courseware's self-paced nature their comments ranged from "your own pace and time" and "proceed at my own speed and not some fast talking instructor" to "skim through the parts I was familiar with" and "didn't have to wait for others to catch up." Related to the self-paced and adaptive nature of the CVBI courseware, many of the participants characterized this computer-based training as more personal than conventional training. "It gave you what you needed," "the graphics and instruction were directed to me and not just a class," "more personal, learned at my pace" and "serious one-on-one competition." Finally, many of the participants commented on the clarity and simplicity of the instructional materials with comments such as "simple to understand, a lot simpler to remember," "the computer explained clearly," "more explanatory and simple" and "broken down to a level where all soldiers should understand."

The participants also provided several negative comments about selected features of the courseware. Their most frequent complaint was their inability to change tests answers. The experimenters and courseware designers relearned two valuable lessons in this area. First, any student input at a workstation, including a test answer, may be the result of an accidental rather than intentional user entry. Students must have the opportunity to both verify and rectify their answers immediately after they have been entered. The second lesson is a little more complicated. How long should students be allowed to go back and change their answers on a test? For the relatively open-classroom we had anticipated for 19K BNCOC in which students might leave their workstation at any time, even during a test, the software prevented students from going back and changing their answers once they had moved to the next test item. But this inflexibility is not typical of most test-taking situations in which no answers are final until the student has "turned-in" the completed exam. Before implementation of this TTFA courseware the software will be revised to provide this more natural test-taking scenario in which answers can be changed until students have completed their exams, but proctor and security measures must be intensified.

Training Efficiency. Another important factor in the evaluation of a training technology, or development of a courseware product, is training efficiency. The average times required to complete training and testing on this CVBI are presented in Table 4. On the average, computer-based pretests for this block of instruction were completed in less than one hour (i.e., 47 minutes). For participants not passing these pretests and requiring remedial training, the average time required to complete their training and the post-tests was less than three hours.

Table 4

Completion Times^a for Training and Testing

Tasks	Pretests		Training + Posttest		Total	
	Average	Range	Average	Range	Average	Range
Signals	10	4-17	43	16- 99	53	20-116
Positions	5	3-11	15	10- 23	20	13- 34
Coordinates	17	6-31	41	16- 99	58	22-130
Vehicle	15	2-24	73	14-139	88	16-163
	<u>47</u>	<u>15-83</u>	<u>172</u>	<u>56-360</u>	<u>219</u>	<u>71-443</u>

^aCompletion times expressed in minutes.

Determining the relative training efficiency of this CVBI compared to conventional training is difficult because remedial training is not a formal component in 19K BNCOC's Program of Instruction. While diagnostic testing is routinely conducted for this course, remedial training is primarily each students responsibility. Evening study hall times for remediation are scheduled into the 19K BNCOC course cycle and proctors are available to assist students, but official records of remedial training times are not maintained.

Training time for each of these Skill Level 1 remedial tasks are available for entry-level personnel, but a comparison of these entry-level data with the experienced personnel in this setting would be misleading; remedial training for the current participants, and 19K BNCOC personnel in general, is a review of the entry-level training they received approximately three years earlier.

Nevertheless, the automated availability of training efficiency data, such as that provided in Table 4, is an important feature unique to computer-based training technologies. Adoption of this and similar CBI Army-wide, would readily provide Army trainers a valid indicator of skill level retention and cadre requirements for remediation.

Finally, the range of times required for training and testing that are presented in Table 4 provide an indication of the diversity of soldier training requirements within a relatively homogenous sample. On the average, the total time required to complete all training and testing for these remedial tasks, ranged from a minimum of just over one hour to a maximum requirement well over seven hours. Since remediation is ultimately each soldier's responsibility, the availability of self-paced and adaptive instructional technologies is an important training resource. Results such as those provided in Table 4 should make both instructors and students of 19K BNCOC more aware of each soldier's unique remediation requirements, and provide administrators the data needed to more effectively schedule both formal and remedial training within the 19K BNCOC course cycle.

CONCLUSIONS

Results from this evaluation suggest CVBI courseware provides an effective training technology for meeting at least some of the remedial training requirements of 19K BNCOC. For each of the remedial tasks evaluated--Use Visual Signals, Establish Tank Firing Positions, Determine Grid Coordinates and Identify Armored Vehicles--participants' gain scores demonstrated significant improvements. The design of the evaluation ensured that these improvements were not due to participant's increased familiarity with the test items and formats or the computer delivery system. With respect to normative course standards, the courseware raised participants from a pretest average of "No Go" to a posttest average of "Go" after one training session for three of the four tasks evaluated. In addition, participants' subjective evaluations of this courseware suggest that they regarded it as better than conventional training methods. While training efficiency could not be directly determined, the diversity of the participants' need for remedial training strongly supports the adaptive nature of training technologies such as CVBI.

This remedial courseware is now ready for validation trials in 19K BNCOC. Key characteristics of the validation trials are that students currently enrolled in the BNCOC course will receive this CVBI training and testing and course instructors, rather than TTFA support personnel, will operate the courseware delivery system. Validation trials are expected to be followed by evaluations of the courseware's effectiveness in transfers to field settings.

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APPENDIX A
OFF-LINE EVALUATION MEASURES

BIOGRAPHICAL QUESTIONNAIRE

Subject # _____ Date _____

Social Security # _____ Rank E - _____ O - _____

1. How long have you been in the service? _____ years _____ months

2. How old are you? _____ years _____ months

3. What is your primary MOS/SC? _____

4. What is your secondary MOS/SC? _____

5. What is your current Unit? _____

6. Please check each of the following courses you have attended:

PLDC _____ BNCOC _____ ANCOC _____ AOC _____ AOAC _____

7. Check each of the following statements that are true for you.

_____ I have no previous experience with computers.

_____ I frequently play video games.

_____ I own a home computer.

_____ I have received formal training on how to use a computer.

_____ I have previously participated in training delivered by a computer.

_____ I have a lot of experience with computers.

8. What is your highest academic level completed? (Check one below.)

High School _____ GED _____ Some College _____ College Graduate _____

9. How would you describe your "handedness" or preferred hand? (Check one below.)

Right handed _____ Left handed _____ Both hands _____

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STUDENT RECORD SHEET FOR REMEDIAL TRIALS

(EVEN numbered students)

Student Number: Primary _____ Additional _____

SEQUENCE	PRETEST SCORE	POSTTEST SCORE	PROBLEM/SOLUTION
	G OR NG/# CORRECT	G OR NG/# CORRECT	

Land Navigation

ID Features (12)	_____ / _____	_____ / _____	_____ / _____
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Det. Elevation (6)	_____ / _____	_____ / _____	_____ / _____
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Remedial

Six Digit Grid (10)	_____ / _____	_____ / _____	_____ / _____
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Radio Set (3)	_____ / _____	_____ / _____	_____ / _____
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Visual Signals (16)	_____ / _____	_____ / _____	_____ / _____
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Tank Positions (12)	_____ / _____	_____ / _____	_____ / _____
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_____	_____ / _____	_____ / _____	_____ / _____
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Land Navigation

ID Features (12)	_____ / _____	_____ / _____	_____ / _____
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Det. Elevation (6)	_____ / _____	_____ / _____	_____ / _____
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POSTTEST QUESTIONNAIRE

Student #: _____

Date: _____

We would like to ask you a few final questions about how you evaluate the computer-based training that you have just experienced.

1. In general what did you like best about the computer-based training?
Please briefly write your answer below.

2. In general what did you like least about the computer-based training?
Please briefly write your answer below.

3. How do you rate the overall effectiveness of this computer-based training?
Please circle the number below (1-5) that indicates your answer.

1	2	3	4	5
VERY POOR TRAINING	POOR TRAINING	AVERAGE TRAINING	GOOD TRAINING	VERY GOOD TRAINING

4. How do you rate this computer-based training compared to standard or conventional training in the same subject areas? Please circle the number below (1-5) that indicates your answer.

Computer-based training is:

1	2	3	4	5
MUCH WORSE THAN CONVENTIONAL	A LITTLE WORSE THAN CONVENTIONAL	THE SAME AS CONVENTIONAL	A LITTLE BETTER THAN CONVENTIONAL	A LOT BETTER THAN CONVENTIONAL

5. What could be done to improve the computer-based training? Please write suggestions below.

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